



Biomass Prospects Global and Local

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Biomass Supply Chain Boundary Condition 1: Fuel vs Food



- World has estimated 3,245,566 km² (2008 CIA) of irrigated land and 16,510,000 km² of land that is suitable for crop production
- Best case photosynthesis is 6% efficient for converting sunlight to biomass (Zhu et al., Current Opinion in Biotechnology, April 2008)
- 8 full hours of sunlight at 1kW/m² gives 574 trillion kWh/yr of biomass from irrigated land
- 144 trillion kWh/yr is current marketed global energy consumption of which ~15% is used for electric generation (<http://www.eia.gov/oiaf/ieo/world.html>)
- Global population of 7 billion (2014) requires calorie equivalent of 3.4 trillion kWh/yr, but that is not being met

Biomass Supply Chain Boundary Condition 2: Green vs Green(\$)



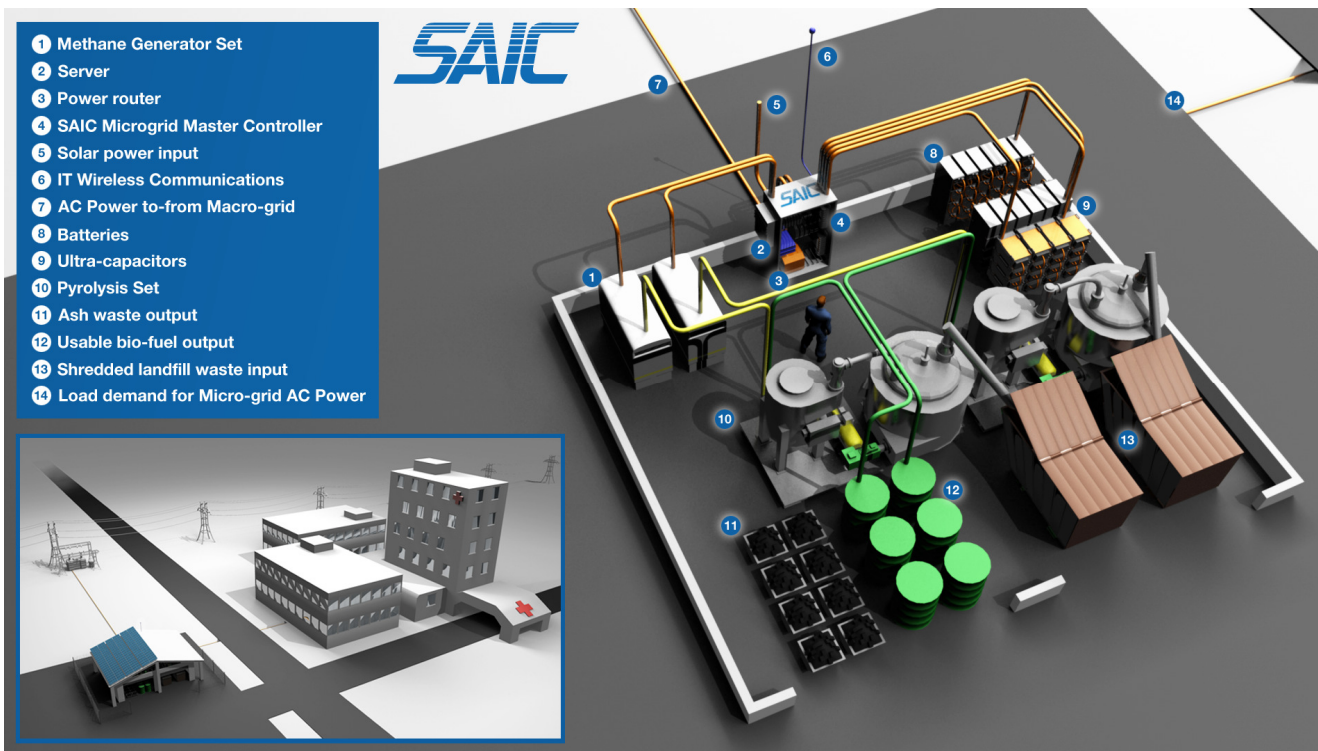
- Need to beat price of gas at the pump
 - 6% light to biomass conversion efficiency
 - >70% of biomass is water and must be removed
 - refinement losses
 - transport losses
 - Don't forget to replace the nitrogen
 - Today's price of corn \$313/metric ton or 14 cents/lb
 - Material cost for 1 gallon of ethanol is \$2.90 (2.7 gal/56 lb bushel)
<http://www.ers.usda.gov/AmberWaves/April06/Features/Ethanol.htm>
 - 2010 total cost for gallon of ethanol \$4.18 with corn at 7 cents/lb
http://www.fapri.missouri.edu/outreach/publications/2010/FAPRI_MU_Report_01_10.pdf

**Today price for ethanol is \$5.67 per gallon, but only 66%
energy content of gasoline**



- Waste to Energy (biomass now)
 - Thermochemical conversion
 - Anaerobic digestion
- Energy Crops (biomass future ?)
 - Algae
 - Switch Grass etc
 - Crop byproducts (ie cornstover, peanut hulls)

Innovative Concept –System to Convert Waste to Power Using Pyrolysis



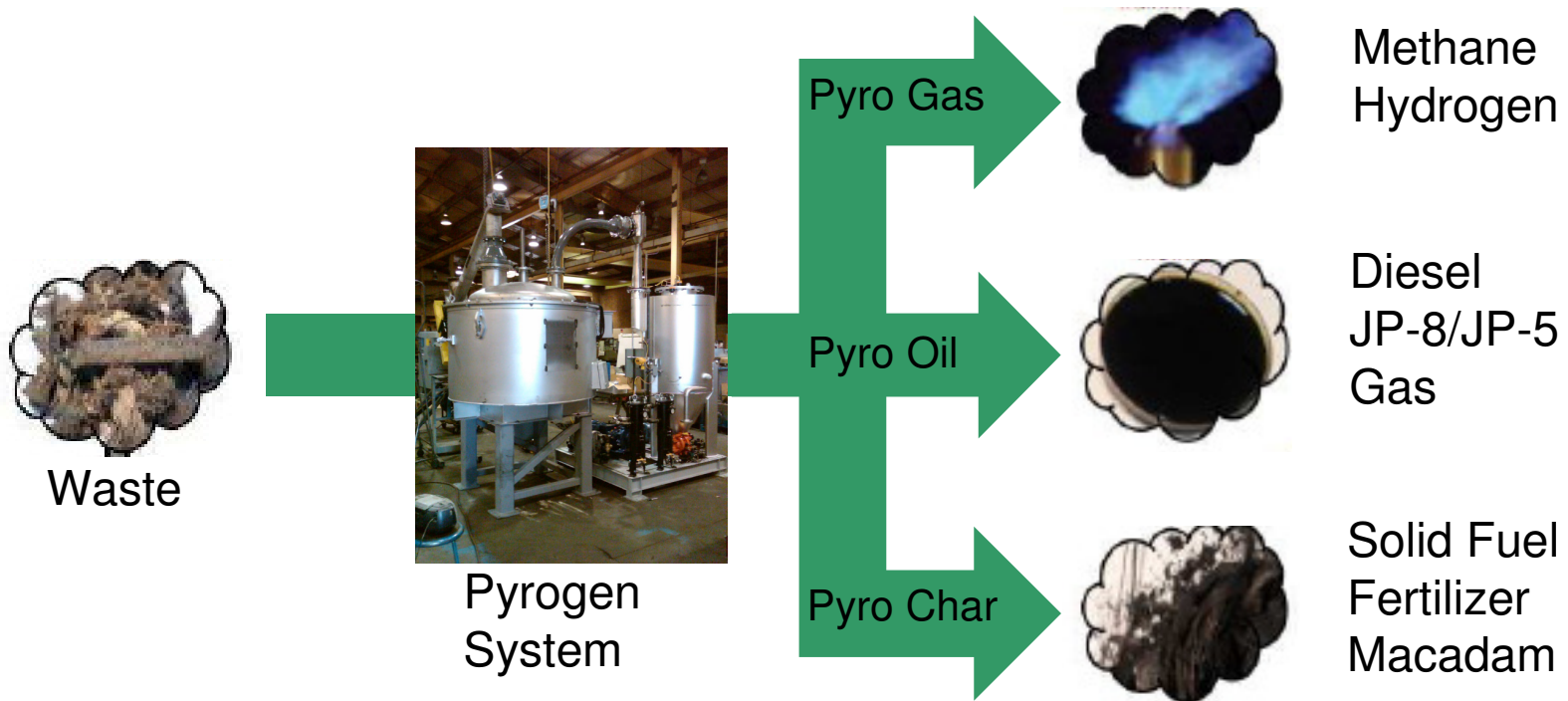
The pyrolysis process uses thermal conversion in the absence of oxygen to transform waste materials into useful fuel ,energy and other byproducts.

(scientist, engineer, innovator)

Energy | Environment | National Security | Health | Critical Infrastructure

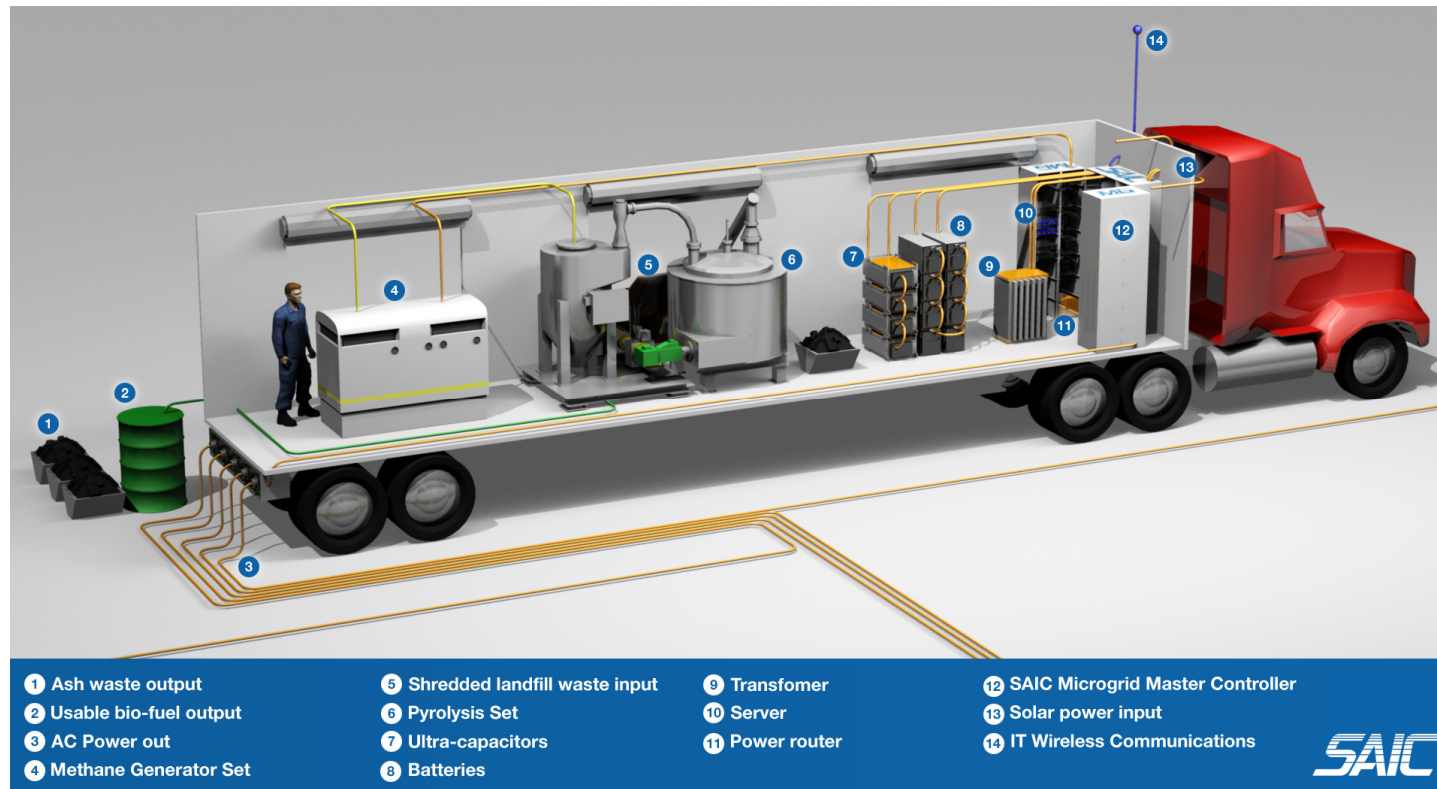
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From Science to Solutions

What is Pyrolysis



Pyrolysis uses thermal conversion, typically at 800 °F or higher, in the absence of oxygen to transform waste materials into useful fuel ,energy and other byproducts.

Reality Check Step 1: Will It Work



- Will it work? – Engineer & Technician
 - Build a prototype
 - Test and validate system in controlled setting
 - Design Cost Effective Solution

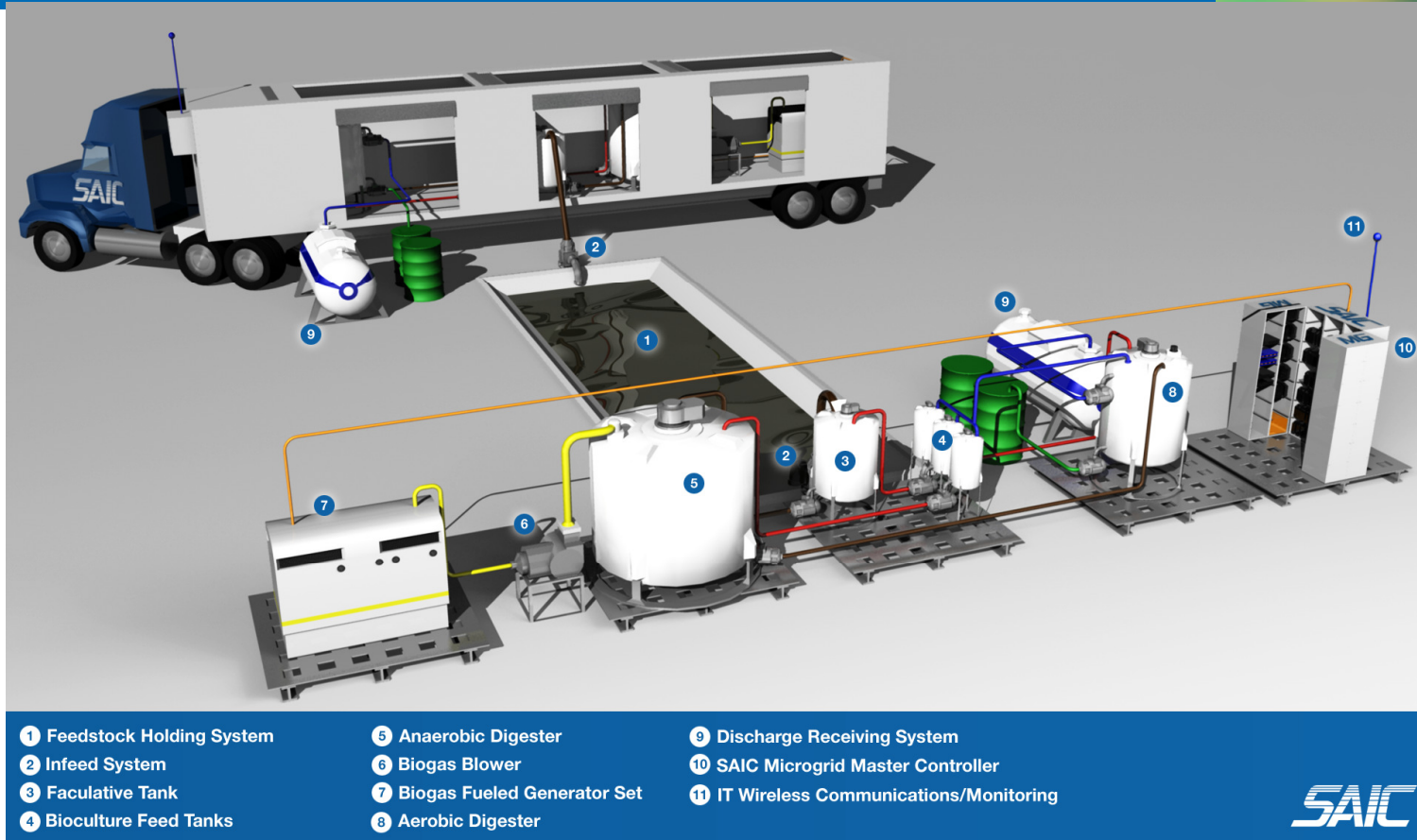
Reality Check Step 2: Will It Pay For Itself



Operation Parameter	Associated Dollar Value	Additional Details
Capital Investment	\$4,500,000	For 2 ton/hour system
Revenue/year	\$2,543,440	
Revenue from 2 MW average power output/year	\$1,620,600	Base price of \$0.07 per kWh + \$0.025 kWh renewable premium
Revenue from Pyro-Char/year	\$125,000	2500 ton/year sold at \$50/ton
Revenue from Pyro-Oil/year	\$500,000	1,000,000 gal/year at \$0.50/gal
Revenue from Tipping Fees/year	\$297,840	17,520 tons/yr at \$17/ton
Operations and Maintenance Costs/year	1,537,600	
Natural Gas Fuel Supplement/year	\$662,000	50% of power from natural gas priced at \$7.00 per MCF
Maintenance Costs/year	\$525,600	Estimated to be \$0.03 for every kWh produced, includes taxes
Labor Costs/year	\$350,000	1 onsite 1 on call 24/7
Annual Profit	\$1,005,840	Payback is roughly 6 years

Is there a market? Business/Financial Analyst

Multi-Stage Digester



Business Model – Multistage Digester 50 tons/day

Capital Investment \$1,500,000 (includes generators)

Operation Parameter	Dollar Value	Additional Details
Revenue/year	\$556,600	
Revenue 375 kw constant power/yr	\$304,000	\$0.0925 per kWh (from low sulfur gas)
Revenue Organic Fertilizer/yr	\$106,200	177 ton/year at \$600/ton
Revenue High Protein Feed/yr	\$26,400	44 ton/year at \$600/ton
Local Cost Avoidance/yr	\$120,000	No Permitting or disposal
O&M Costs/year	\$162,000	
Bacterial Mixes/yr	\$35,000	Includes license fees
Maintenance, Insurance, Taxes	\$64,000	
Labor Costs/year	\$63,000	1 person part time
Annual Profit	\$394,600	Payback is 4 years